WEF AND AZ WATER STUDENT DESIGN COMPETITION PROJECT PROPOSAL

CENE-476

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Abbreviations

AA – Administrative Assistant

ASU – Arizona State University

AZ- Arizona

AZDEQ – Arizona Department of Environmental Quality

BOD – Biological Oxygen Demand

CWA – Clean Water Act

ENG – Engineer

EPA – Environmental Protection Agency

INT – Intern

LAB – Lab Technician

NAU – Northern Arizona University

NPDES – National Pollution Discharge Elimination System

SENG – Senior Engineer

UofA – University of Arizona

WEF – Water Environment Federation

WSDC – Water Student Design Competition

WWTP – Wastewater Treatment Plant

GI – Grading Instructor

TA – Technical Advisor

1. Project Understanding

The project is understood in terms of its purpose, background, technical considerations, potential challenges, and stakeholders.

1.1. Project Purpose

The purpose of this project is analyze and design a municipal wastewater treatment plant (WWTP) for a community chosen by the Arizona (AZ) Water Student Design Competition (WSDC); an annual competition organized by the AZ Water Association and Water Environment Federation (WEF). Students from higher educational institutions such as Northern AZ University (NAU), AZ State University (ASU), and University of AZ (UofA) work on designing a WWTP from scratch or improving upon an existing one by looking at the treatment processes, tank design, wastewater demand, life-cycle cost, and other similar wastewater plant characteristics.

1.2. Project Background

Various universities in AZ compete in the AZ Water Student Design Competition every year. The guidelines, rules, city details and location, current status of the site, design/analysis requirements, and other important information are anticipated to be released in January in 2021. The problem statement given to the students changes every year, but involves design, or redesign, of a WWTP in AZ. This problem statement might want the students to upgrade an existing WWTP to meet new regulations, user demands, or technology advancements. As an example, the NAU 2020 team was tasked with retrofitting the Kyrene Water Reclamation Facility in Tempe, AZ with the end goals of reducing the capacity of the facility from nine-million-gallons-per-day to three-million-gallons-per-day, and operating on 100% renewable energy. Figure 1.1 and Figure 1.2 below are the existing layout and layout designed by the team, respectively of course.

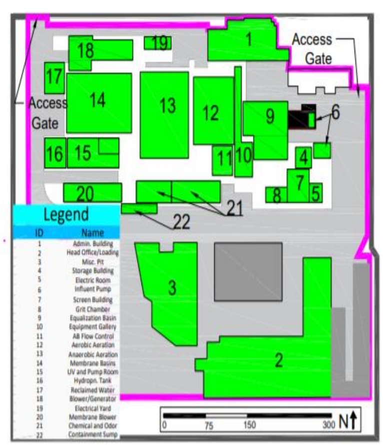


Figure 1.1 Existing Facility Layout

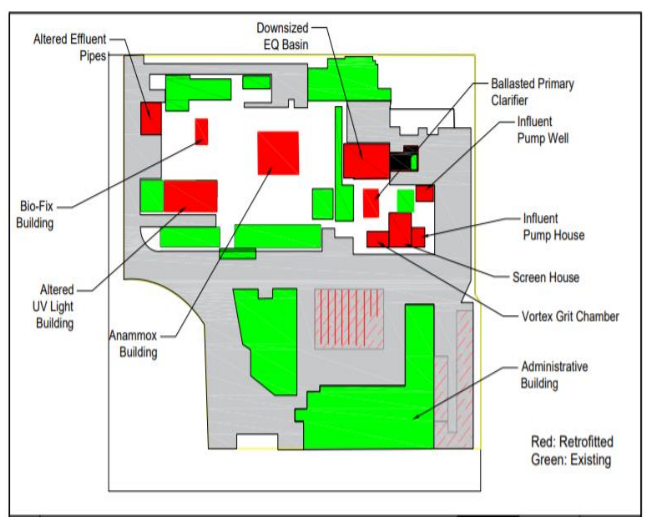


Figure 1.2 Design Facility Layout

1.3. Technical Considerations

This project requires a sound understanding of professional regulations, hydraulics, and the wastewater treatment processes.

1.3.1. Regulations

The plant will be subject to the regulations set by the federal, state, and local government. Federal regulations will come from the Environmental Protection Agencies (EPA) Clean Water Act (CWA) and National Pollution Discharge Elimination System (NPDES). State regulations (Arizona's) comes from AZ's Department of Environmental Quality (AZDEQ). Local government regulations will need to be researched once the exact location is provided.

1.3.2. Hydraulic Design

A hydraulic analysis will be conducted to determine the pumps needed throughout the plant and any pump potential needed at the end to provide sufficient head to allow the effluent to make it to its destination. The analysis will include, but not be limited to, avoiding cavitation, avoiding air seals, minimum velocities to prevent pipe blockage, and possible pump combinations that match the system curves. There may also be a need to analyze the area the plant will be servicing to determine the total inflow based on the typical daily water demand graph, population density and service area, and how long the plant is supposed to last until it becomes insufficient.

1.3.3. Treatment Process Design

The desired level of treatment will include, at a minimum, secondary treatment, but may include tertiary treatment at the clients' request. With the recent issue of AZ's first permit for recycled water, the WWTP may also include treatment steps for producing recycled water.

Broadly, primary treatment consists of removing particles large enough to interfere with the succeeding steps; secondary treatment consists of using biological process to remove harmful chemicals; tertiary treatment consists of removing bacteria and a wider range and quantity of harmful chemicals; and recycled water has even more harmful bacteria and chemicals to the point it exceeds drinking water standards.

1.3.4. Solids handling

The settled sludge from the primary and secondary treatment will need to be removed and then treated before it can be disposed of. Solids handling includes the thickening, digestion, dewatering, sludge disposal or re-use of the sludge, and analysis of the sludge quantity to ensure compliance with Arizona regulations

1.3.5. Sustainable Design

The WWTP needs to be made economically and environmentally sustainable. Currently available options for sustainability will be considered when evaluating and choosing the best design technologies for each component of the treatment process. This could include using combustible materials in the dried sludge as an energy source to power the WWTP.

1.4. Potential Challenges

Several potential challenges present themselves because of items such as receiving the competition rules after the proposal, the location being unknown, being on a tight time schedule, recent world events, and the variability in AZ's climate.

1.4.1. Competition Rules and Requirements

The competition rules and requirements are not yet known. Information may need to be calculated or may be provided or may not be needed at all depending on what the WEF and AZ WSDC constrains are, requirements are, and the information they provide are. This makes researching the required information difficult as the possibilities are exceptionally broad.

1.4.2. Location

The location and most of information about it are unknown. This adds to the scope of the preparatory research that needs to be done and adds analyzing the data to an already restrained timeline.

1.4.3. Time Management

Time management is always a challenge, but current world conditions (COVID-19 pandemic) have reduced the amount of the time available for the project making it exceptionally noteworthy for this project.

1.4.4. COVID-19

COVID-19 is likely to effect several things such as the ability to conduct a site visit, whether the presentation will need to be in-person or virtual, the group's ability to work together, and adds the possibility of team member becoming infected increasing the individual members workload (whether that be temporary or permanent).

1.4.5. AZ Climate Variability

While it is known that the WWTP will be located within AZ, the state has a wide variety of weather and climate. This again widens the scope of the preliminary research with a range of possible climate challenges.

1.5. Stakeholders

Those who live close to the plant have their quality of living at stake. The plant might produce unpleasant odor, require easements onto their property, cause changes to existing traffic infrastructure, and while under construction result in additional noise pollution and traffic in the area. The aquatic, plant, and animal life within the effluent area are obviously affected by the effluent, and, as a secondhand effect, those who use these places for recreational purposes such as camping, fishing, swimming are at stake. If the WWTP produces reclaimed or recycled water those using that water will want the quality to be as high as economically possible.

As the ADEQ approves the WWTP, their stake is in their own reputation in that if they approve that plant it turns out poorly it would reflect bad on them. They also have a general interest in helping produce quality WWTP as that was a part of the reason behind their creation. The city has its name at stake. The ability to support and attract growth, both in population and business. Local residents and business might find and easing on existing wastewater regulations and have an obvious stake in that they are paying the taxes that fund the project.

2. Scope of Services

The scope includes the eight tasks of competition preparation, site investigation, treatment design, hydraulics, cost of the project, project impacts, the projects deliverables, and management of the project.

2.1. Task 1. Prepare for Competition

The treatment processes involved in a WWTP and the registration requirements will need to be known prior to starting the competition.

2.1.1. Task 1.1. Research Treatment Processes

Each treatment step needs to be fully understood in the context of what the step encompasses, the regulations the guide the step, and how to achieve those regulations limits. This could include looking at sites that are expected to be similar to the site, talking to professional in field, and finding emerging technologies for each step of the treatment process.

2.1.2. Task 1.2. Registration

The group must be registered members of the AZ water organization and register for the WEF competition itself. The deadlines and fees for these registrations are not yet concrete or known.

2.2. Task 2. Site Investigation

Information about the WWTP site will need to be collected for analysis and use during the design.

2.2.1. Task 2.1. Site Visit

Visiting the site allows the team to collect topological data, soil data, see the existing WWTP, and talk to the existing workers about what improvements they believe the plant needs.

2.2.2. Task 2.2. Analysis of Provided Data

The data collected from the site visit will need to be organized and then analyzed so it can be incorporated into the design process.

2.2.2.1. Task 2.2.1. Treatment Plant Constraints/Criterion

Before the treatment design process can begin, the constrains and criterion imposed by the site need to be found. These are things such as the design flow of the plant over its lifespan, available spacing, and budget.

2.2.2.2. Task 2.2.2. Source Water Characteristics

It is important to know what contaminants are in the wastewater coming into the plant as the design may need to remove some of them. This information should come from competition rules. Information not provided by the competition or collected from the site visit will be assumed from common data/values and stated as such.

2.2.2.3. Task 2.2.3. Develop Site Plan of Existing Plant

Using the data either provided by the competition or collected from the site visit a plan view of the WWTP will be created to later be used the design of the plant layout.

2.3. Task 3. Treatment Design

All the treatment steps that a WWTP must go through will need to be designed and there are a few optional additional steps that must be planned for.

2.3.1. Task 3.1. Design Capacity

The population and design flow for the wastewater treatment facility will be determined after getting more information from the competition prompt. This will be used to determine the best treatment technologies.

2.3.1.1. Task 3.1.1. Estimate Daily Demand Factors

Daily demand factors will be either be given in the competition prompt or assumed to be typical values.

2.3.1.2. Task 3.1.2. Calculate End of Lifecycle Capacity

It is expected that the lifespan of the plant will be provided at a minimum so that it may be used to estimate the capacity of the WWTP at the end of its lifecycle. More information may be given which will shorten this calculation.

2.3.1.3. Task 3.1.3. Effluent Regulations

Effluent standards for the state of AZ will need to be adhered to along with additional requirements for effluent limits, depending on the local jurisdiction the WWTP falls under.

2.3.2. Task 3.2. Preliminary Treatment

The preliminary treatment of wastewater is one of the most crucial steps in the treatment process. During this step, large objects that have mixed in with the wastewater will be removed.

2.3.2.1. Task 3.2.1. Evaluate and Choose Preliminary Treatment Options

Heavy solids such as sand, gravel and cinder are removed in this step by finding the most adequate technology based on a decision matrix comparing different types of grit removal options. While most grit chambers are similar, a poor choice in the device will likely cause the rest of the treatment process to be inefficient.

2.3.2.2. Task 3.2.2. Design Preliminary Treatment Options

The preliminary portion of treatment will be designed once the best technology is determined.

2.3.3. Task 3.3. Primary Treatment

The primary treatment stage is where small material in the wastewater has time to settle in a clarifier or basin and is subsequently removed.

2.3.3.1. Task 3.3.1 Evaluate and Choose Primary Treatment Options

A decision matrix will be utilized to figure out which method(s) to use for the primary treatment stage.

2.3.3.1.1. Task 3.3.1.1. Sedimentation basin

There are many sizes and designs for sedimentation basins, and several factors to consider when choosing one such, as the retention time and overflow rate of the basin. Rectangular basins, double deck basin, circular clarifiers and solids-contact clarifiers are some typical sedimentation basin options.

2.3.3.1.2. Task 3.3.1.2. Coagulation/Flocculation

A coagulant may be needed to settle particles in the sedimentation basin. If needed, the coagulant used will be determined through a decision matrix in conjunction with the sedimentation basin.

2.3.3.1.3. Task 3.3.1.3. Primary Sludge Handling

A decision matrix will also be used to determine what to do with the primary sludge collected at the end of the primary treatment of the wastewater as well as how often it needs to be collected.

2.3.3.2. Task 3.3.2 Design Primary Treatment

The primary portion of treatment will be designed once the best technology is determined.

2.3.4. Task 3.4. Secondary Treatment

The secondary treatment is the stage of the wastewater treatment process when microorganisms are used to remove contaminants from the wastewater. The technologies of activated sludge, aerobic lagoons, trickling filters, and bioreactors will be reviewed as some of the several ways to remove wastewater contaminants.

2.3.4.1. Task 3.4.1. BOD/Organic Matter Removal

The biological oxygen demand (BOD) will need to be controlled and the organic matter will need to be properly removed.

2.3.4.1.1. Task 3.4.1.1 Evaluate and Choose BOD/Organic Matter Removal Options

A decision matrix will be used to determine what to do with the primary sludge at the end of the primary treatment of the wastewater as well as how often it needs to be collected.

2.3.4.1.2. Task 3.4.1.2 Design BOD/Organic Matter Removal

Once the technology for BOD/organic matter removal has been chosen, the team will go through the process of designing the device for BOD removal.

2.3.4.2. Task 3.4.2. Disinfection

Wastewater contains harmful microorganisms that must be reduced to levels set by regulations before the wastewater can be released as effluent.

2.3.4.2.1. Task 3.4.2.1 Evaluate and Choose Disinfection Options

There are different ways to disinfect the water after the organic matter is removed including ultraviolet treatment, ozone, copper ionization, carbon absorption and ozonation. A decision matrix will be utilized to figure out which method(s) to use.

2.3.4.2.2. Task 3.4.2.2 Design Disinfection

Once the method for disinfection is determined, the disinfection technology will be designed.

2.3.5. Task 3.5. Tertiary Treatment

Tertiary is an optional step in the wastewater treatment process. When used it will further remove contaminants to ensure the water is up to effluent standards. Some technologies to review are filtration (sand, gravel, or charcoal), membrane technology, or advanced oxidation.

2.3.5.1. Task 3.5.1. Evaluate and Choose Tertiary Options

The tertiary treatment options will be analyzed, and a decision matrix will be used to determine the best technology.

2.3.5.2. Task 3.5.2. Design Tertiary Options

The tertiary portion of treatment will be designed once the best technology is determined.

2.3.6. Task 3.6. Biosolids management

After the treatment of the wastewater, the sludge must be dealt with. This is typically preceded by treatment of the biosolid before it can be disposed of, at a landfill or incinerator, or repurposed, for land applications such as fertilizers. Regulations set by federal, state, and local governments must be followed when determining the level of treatment depending on how the biosolids are "dealt with"

2.3.6.1. Task 3.6.1. Evaluate and Choose Biosolids Options

The EPA's regulations in addition to the amount of sludge, cost and size of the treatment plant will help determine what to do with the biosolids. A decision matrix will be used to determine the best option for biosolids handling.

2.3.6.2. Task 3.6.2. Design Biosolids Options

The technology for biosolids handling will be designed after an option is decided upon.

2.4. Task 4. Hydraulics

While the hydraulics of a WWTP are not complex, a basic analysis needs to be done.

2.4.1. Task 4.1. System Analysis

The pipe system is primarily analyzed to aid in the selection of pump systems but is also done to ensure there is no damaging hydraulic phenomena such as cavitation or water hammer.

2.4.2. Task 4.2. Pump Selection

A pump system will be designed based on the flow and head needs of the hydraulic system.

2.5. Task 5. Cost of Project

The cost of initial construction and cost over the entire lifespan of the plant need to be known. No point planning a plant you cannot build. No point building a plant you cannot afford to run.

2.5.1. Task 5.1. Construction Cost

Construction cost is determining the cost of services, equipment, transport, materials, that are necessary to construct the WWTP. Determining the construction expense is necessary to ensuring that the contractors have all the resources necessary for them to complete their tasks.

2.5.2. Task 5.2. Operation Cost

Operation costs are any costs that are related to the sustained operation of a business, facility, project, of a device and more. These costs can be for rent, salaries, insurance, director fees etc.

2.5.3. Task 5.3. Expected Lifespan and Lifespan Cost

Expected lifespan is the projection of how long a service, structure, system, or facility will last. Lifespan cost is the sum of the costs that recure over the lifespan of a service, structure, or system.

2.6. Task 6. Project Impacts

The impacts the project, both positive and negative, will need to be weighed in conjunction with the cost of the plant.

2.6.1. Task 6.1. Environmental Impacts

WWTPs help reduce the impact on the environments health by reducing the waste that is released and decreasing pollution. Additionally, the biodegradable material from the treatment process can be reused as a natural fertilizer helping to improve crop yields.

Most negative environmental impacts from a WWTP come from one being incorrectly designed or from the construction phase of a WWTP. The table below gives possible impacts that can arise and what their cause would be during the construction or operation phase of the plant.

Table 2.1 Sources of Environmental Impacts

Impact	Construction phase	Operation phase
Degradation of soil & natural resources		Deterioration of the treated water in the event of a breakdown
Pollution of water resources	improper disposal of wastewater and hazardous waste (ex: oil)	Any risks that are associated with the disposal of the final effluent
Degradation of Air Quality	Air pollution from pollutants (ex: PM10, NOx, CO) from excavating, transporting, vehicles, etc.	Any air pollution due to generators
Damage to Plant life		Contamination of vegetation because of low quality of the final effluent water

2.6.2. Task 6.2. Economic Impacts

Having the ability to treat an increased amount of wastewater allows for potential improvement in the local economic activities as industries that discharge large amounts of wastewater can expand. This has the potential to increase jobs, both from the plant and in expanding industries.

The negative economic impacts from the WWTP come from the cost of construction and maintenance along with the risks associated with these phases.

2.6.3. Task 6.3. Societal Impacts

The presence of a WWTP reduces the potential of disease-causing bacteria, compared to not having one, leading to an improvement in the lives of the local society.

Negative impacts mostly effect those near the plant as a WWTP is typically loud, smelly, unsightly, and depending on the location may require re-routing roads, temporarily or permanently.

2.7. Task 7. Project deliverables

The project has several deliverables required of it by the competition (the client) and the instructors.

2.7.1. Task 7.1. 30% Completion

The 30% completion should see strong progress along most of the technical tasks.

2.7.1.1. Task 7.1.1. 30% Report

The 30% report will show the work completed for Task 1: Prepare for Competition, Task 2: Site Investigation, Task 3.1: Treatment Plant Requirements, Task 3.2: Preliminary, Task 3.3: Primary, and Task 4.1: System Analysis.

2.7.1.2. Task 7.1.2. 30% Presentation

This presentation will be an update on the progress made by the team at 30% completion of the project.

2.7.2. Task 7.2. 60% Completion

The 60% completion should see near completion to completion of the technical tasks.

2.7.2.1. Task 7.2.1. 60% Report

The 60% report will show the work completed from Task 1: Prepare for Competition all the way through the end of Task 5: Analyze Project Impacts.

2.7.2.2. Task 7.2.2. 60% Presentation

This presentation will be an update on the progress made by the team at 60% completion of the project.

2.7.3. Task 7.3. 90% Completion

The 90% completion should see the utter completion of the technical tasks and near completion any reports, presentations, websites, competition deliverables, memos, etc.

2.7.3.1. Task 7.3.1. 90% Report

The 90% report is the first draft of the final report. This report will include all sections of the design and analysis of the wastewater treatment facility.

2.7.3.2. Task 7.3.2. Practice Presentation

This presentation is the first draft of the final presentation on the design and analysis for the wastewater treatment facility.

2.7.3.3. Task 7.3.3. 90% Website

This deliverable will be the nearly completed website including all pertinent information and required documents.

2.7.4. Task 7.4. 100% Completion

The 100% completion should see the entire project fully completed.

2.7.4.1. Task 7.4.1. Final Report

This report will be the completed report on the entire project. It includes all sections of the design and analysis of the wastewater treatment facility.

2.7.4.2. Task 7.4.2. Final Presentation

The final presentation will include all the key information about the design and analysis for the wastewater treatment facility

2.7.4.3. Task 7.4.3. Final Website

This deliverable will be the finished website including all pertinent information and required documents.

2.7.5. Tasks 7.5 Competition Deliverables

The deliverables needed for the competition are unknown but will need to be added to the scope of the project when they become available.

2.8. Task 8. Project Management

Project management will occur continuously throughout the entire project via; team, Client, GI, and TA meetings; memo submittals; and careful planning designed to keep the project on track.

2.8.1. Task 8.1. Meetings

Meetings will occur at regular intervals, unless identified as unneeded, between all parties involved in the project.

2.8.1.1. Task 8.1.1. Team Meetings

Meetings will be conducted bi-weekly between the team members to review members progress and assign new tasks.

2.8.1.2. Task 8.1.2. Client/GI/TA Meetings

Meetings with the client are likely to be minimum due to the nature of the project/competition. Meetings with the GI will be on an as needed basis, with the possibility of becoming regular if the need arises. Meetings with the TA will be regular based on the requirements of the group.

Note that all these meetings are grouped together as they are expected to be the same individual for this project.

2.8.2. Task 8.2. Schedule/Resource Management

Every third group meeting will include reviewing the Gantt chart and task due dates to ensure budget, staffing, and other resources are managed for project success.

2.9. Exclusions

The scope of this project only includes those items listed in the scope section. This explicitly does not include anything related to the transportation of the wastewater to and from the WWTP, the actual construction process of the WWTP, the operation of the WWTP, or treatment of any water that is note wastewater.

3. Schedule

The start date for the project is 1/10/2021 and will progress to the final deliverable which is due 4/27/2021. The major tasks that need to be completed for this project are preparing for the competition, site investigation, treatment design, hydraulics and analyzing project impacts. The duration of this project is 108 days.

3.1. Milestones

The milestones for this project comprise of the 30%, 60% and 90% progress reports, presentations, website, and any additional competition deliverables.

3.1.1. 30% Completion Milestone

The 30% progress milestone will be completed and submitted by 2/9/2021. This milestone will include the completion of Task 1: Prepare for Competition, Task 2: Site Investigation, Task 3.1: Treatment Plant Requirements, Task 3.2: Preliminary, Task 3.3: Primary, and Task 4.1: System Analysis. This will include the 30% report and presentation.

3.1.2. 60% Completion Milestone

The 60% progress milestone will be completed and submitted by 3/9/2021. This milestone will include the completion of Task 1: Prepare for Competition all the way through the end of Task 5: Analyze Project Impacts. This will include the 60% report and presentation.

3.1.3. 90% Completion Milestone

The 90% progress milestone will be completed and submitted by 4/6/2021. This will be the first draft of the final report, presentation, and website. At this point, all work should be completed aside from the final draft of the report, presentation, website, and any additional competition deliverables.

3.1.4. 100% Completion Milestone

The final presentation will be completed and submitted by 4/16/2021. The final report and website will be completed and submitted by 4/27/2021. Any additional competition deliverables will also need to be completed for this milestone.

3.2. Critical path

The critical path for this project includes completing the selected milestones ending in the completion of the final deliverables. The major tasks on the critical path include preparing for the competition, site investigation, treatment design, hydraulics and analyzing project impacts. The minimum duration of this project is 108 days which can be seen in the attached Gantt chart. The critical path needs to be followed to ensure the team does not fall behind on work that needs to be completed. In order to maintain the timing and duration of the work to be completed, the team has set aside a set number of hours per week that they will be committed to work on the tasks at hand. If there is more work to be done than anticipated, the team will need to put in work on weekends to stay on track. The Gantt chart will be referenced and updated regularly to ensure the tasks are done in a timely manner.

4. Staffing

The project staffing is separated into the five jobs Senior Engineer (SENG), Lab Technician (LAB), Engineer (ENG), Engineering Intern (INT), and Administrative Assistant (AA). A SENG would have their professional engineering certificate. An ENG would have completed their fundamentals exam and be “studying” under the SENG. The LAB would be specialized in a particular lab work required for the project. The INT would be, at a minimum, an engineering student from an academic institute. An AA would be someone with experience in managing.

The work hours were assigned to the jobs using the following assumptions. The SENG is an expert in the fields the project encompasses and has the final review on tasks; they typically do not do the work, but manage and guide the ENG. The ENG does the majority of the work hours, but their work must be reviewed by a SENG before it is complete. The LAB does work pertaining to data collection, typically through lab work, but does little data analysis; that is reserved for the ENG, SENG, and INT. The INT is the to the ENG as the ENG is to the SENG; all their work is done reviewed by an ENG before it can be considered complete, but they do not do as much as the ENG because of the training they require for the tasks would put the project behind schedule. The AA takes on the role of retrieving and disseminating work information during the course of the project by setting meetings, revising/editing repots, and updating the schedule/resources.

Table 4.1 shows the summary of the staffing hours estimates by work hours per job. The total estimated hours are 635. A table showing the hours per major task used to make this table can be found in 7.Appendix 1.

Table 4.1 Staffing Summary

Task Number	Task Name	Work (Hours)	SENG	ENG	LAB	INT	AA
1	Prepare for Competition	20	2	6	3	6	3
2	Site Investigation	55	14	5	17	0	19
3	Treatment Design	325	41	176	11	86	11
4	Hydraulics	40	4	23	1	11	1
5	Cost of Project	30	3	18	0	9	0
6	Project Impacts	60	6	33	3	15	3
7	Project Deliverables	105	20	51	8	22	4

5. Cost of Engineering Services

Table 5.1 breaks down the cost of engineering services by hours-and-pay per position on the team. It also includes the flat cost of necessary expenses such as site visits, printing, and fees imposed by the competition. The total staffing services are $47,533.5 for staffing, $1,494.84 for travel, and $225 for supplies for a total of $49,253.34

Table 5.1 Cost of Services Summary

Staffing				
	Positions	**Hours**	**Billing Rate**	**Total Pay**
	Senior Engineer	90	$185.00	$16,650
	Engineer	312	$80.00	$24,960
	Lab Technician	43	$45.00	$1,935
	Intern	149	$17.00	$2,533
	Admin Assistant	41	$35.50	$1,455.5
			Subtotal	*$47,533.5*
Travel				
	Item	**Notes**	**Rate**	**Total Pay**
	Site Visit	1 trip at 288 miles	$0.58/ miles	$67.04
	Rental Vehicle	1 day	$62/day	$62
	Competition	1 trip at 310 miles	$0.58/miles	$179.8
	Rental Vehicle	3 days (extra 1 day to return the vehicle)	$62/day	$186
	Hotel	2 rooms 2 nights	$100/ night/room	$400.00
	Meals	2 nights (3 meals per day for 5 people)	$60/person/day	$600
			Subtotal	*$1494.84*
Supplies				
	Items	**Notes**	**Rate**	**Total**
	3D Printing	at 1kg	$0.05/g	$50
	Membership	5 people	$35/person	$175
			Subtotal	*$225*

6. References

[1] K. Abushousha, S. Cai, J. Mitten, W. Levin and J. Ramirez, 05 May 2020. [Online]. Available: https://www.ceias.nau.edu/capstone/projects/CENE/2020/WEF/files/Finals/Final Edits/finalfinal/WEF_Team_FinalReport_CENE486C.pdf. [Accessed November 2020].

[2] O. Agredano, "State Leaders Discuss Arizona's Major Water Challenges," Cronkite News, 03 August 220. [Online]. Available: https://www.pinalcentral.com/casa_grande_dispatch/area_news/state-leaders-discuss-arizonas-major-water-challenges/article_1affd74a-9d90-52f7-a376-78f7a2454e2c.html. [Accessed November 2020].

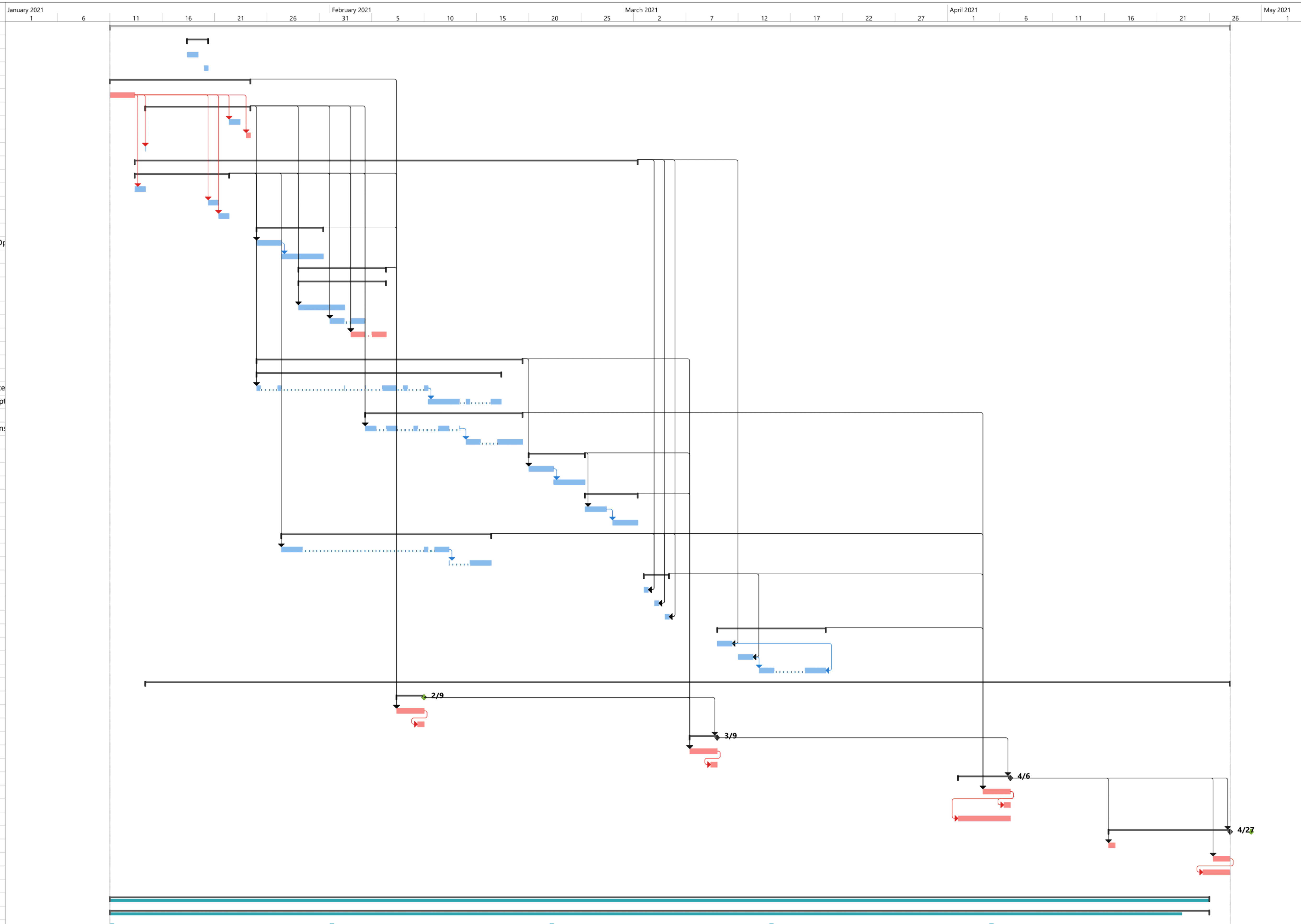
7. Appendix

Appendix 1. Staffing Estimates

Task Number	Task Name	Work (Hours)	SENG	ENG	LAB	INT	AA
1	**Prepare for Competition**	20					
1.1	Research for Treatment Process	15	1	5	2	5	2
1.2	Registration	5	1	1	1	1	1
2	**Site Investigation**	55					
2.1	Site Visit	25	7	0	9	0	9
2.2	**Analysis of Provided Data**	30					
2.2.1	Treatment Plant Constraints/Criterion	15	5	4	2	0	4
2.2.2	Source Water Characteristics	10	1	1	4	0	4
2.2.3	Develop Site Plan of Existing Plant	5	1	0	2	0	2
3	**Treatment Design**	325					
3.1	**Design Capacity**	30					
3.1.1	Estimate Daily Demand Factors	10	1	5	0	4	0
3.1.2	Calc. End of Lifecycle Capacity	10	1	5	0	4	0
3.1.3	Effluent Regulations	10	2	6	0	2	0
3.2	**Preliminary Treatment**	40					
3.2.1	Evaluate and Select Preliminary Treatment Options	20	4	8	2	4	2
3.2.2	Design Preliminary Treatment Options	20	6	10	0	4	0
3.3	**Primary Treatment**	60					
3.3.1	Evaluate and Choose Primary Treatment Options						
3.3.1.1	Sedimentation basin	30	3	17	1	8	1
3.3.1.2	Coagulation/Flocculation	15	1	8	1	4	1
3.3.1.3	Primary Sludge Handling	15	2	8	1	3	1
3.3.2	Design Primary Treatment						
3.4	**Secondary Treatment**	85					
3.4.1	**BOD/Organic Matter Removal**	40					
3.4.1.1	Evaluate and Choose BOD/Organic Matter Removal Options	20	2	11	1	5	1
3.4.1.2	Design BOD/Organic Matter Removal Options	20	2	12	0	6	0
3.4.2	**Disinfection**	45					
3.4.2.1	Evaluate and Choose Disinfection Options	20	2	11	1	5	1
3.4.2.2	Design Disinfection Options	25	3	15	0	7	0
3.5	**Tertiary Treatment**	55					
3.5.1	Evaluate and Choose Tertiary Options	25	3	12	2	6	2
3.5.2	Design Tertiary Options	30	3	18		9	0
3.6	**Biosolids Management**	55					
3.6.1	Evaluate and Choose Biosolids Options	25	3	12	2	6	2
3.6.2	Design Biosolids Options	30	3	18	0	9	0
4	**Hydraulics**	40					
4.1	System Analysis	20	2	11	1	5	1
4.2	Pump Selection	20	2	12	0	6	0
5	**Cost of Project**	30					
5.1	Construction Cost	10	1	6	0	3	0
5.2	Operation Cost	10	1	6	0	3	0
5.3	Expected Lifespan Cost	10	1	6	0	3	0
6	**Project Impacts**	60					
6.1	Environmental Impact	20	2	11	1	5	1
6.2	Economical Impact	20	2	11	1	5	1
6.3	Societal Impact	20	2	11	1	5	1
7	**Project Deliverables**	105					
7.1	**30% Completion**	20					
7.1.1	30% Report	15	3	6	2	3	1
7.1.2	30% Presentation	5	1	3	0	1	0
7.2	**60% Completion**	20					
7.2.1	60% Report	15	3	6	2	3	1
7.2.2	60% Presentation	5	1	3	0	1	0
7.3	**90% Completion**	40					
7.3.1	90% Report	15	3	6	2	3	1
7.3.2	Practice Presentation	5	1	3	0	1	0
7.3.3	90% Website	20	2	12	0	6	0
7.4	**100% Completion**	25					
7.4.1	Final Presentation	5	1	3	0	1	0
7.4.2	Final Report	10	3	3	2	1	1
7.4.3	Final Website	10	2	6	0	2	0
Total							**41**

Appendix 2. Gantt Chart

ID	Task Name
0	**Project1**
1	**1 Prepare for Competition**
2	1.1 Research for Treatment Process
3	1.2 Registration
4	**2 Site Investigation**
5	2.1 Site Visit
6	**2.2 Analysis of Provided Data**
7	2.2.1 Treatment Plant Constraints/Criterion
8	2.2.2 Source Water Characteristics
9	2.2.3 Develop Site Plan of Existing Plant
10	**3 Treatment Design**
11	**3.1 Design Capacity**
12	3.1.1 Estimate Daily Demand Factors
13	3.1.2 Calc. End of Lifecycle Capacity
14	3.1.3 Effluent Regulations
15	**3.2 Preliminary Treatment**
16	3.2.1 Evaluate and Select Preliminary Treatment Op
17	3.2.2 Design Preliminary Treatment Options
18	**3.3 Primary Treatment**
19	**3.3.1 Evaluate and Choose Primary Treatment Options**
20	3.3.1.1 Sedimentation basin
21	3.3.1.2 Coagulation/Flocculation
22	3.3.1.3 Primary Sludge Handling
23	3.3.2 Design Primary Treatment
24	**3.4 Secondary Treatment**
25	**3.4.1 BOD/Organic Matter Removal**
26	3.4.1.1 Evaluate and Choose BOD/Organic Matte
27	3.4.1.2 Design BOD/Organic Matter Removal Opt
28	**3.4.2 Disinfection**
29	3.4.2.1 Evaluate and Choose Disinfection Option
30	3.4.2.2 Design Disinfection Options
31	**3.5 Tertiary Treatment**
32	3.5.1 Evaluate and Choose Tertiary Options
33	3.5.2 Design Tertiary Options
34	**3.6 Biosolids Management**
35	3.6.1 Evaluate and Choose Biosolids Options
36	3.6.2 Design Biosolids Options
37	**4 Hydraulics**
38	4.1 System Analysis
39	4.2 Pump Selection
40	**5 Cost of Project**
41	5.1 Construction Cost
42	5.2 Operation Cost
43	5.3 Expected Lifespan Cost
44	**6 Project Impacts**
45	6.1 Environmental Impact
46	6.2 Economical Impact
47	6.3 Societal Impact
48	**7 Project Deliverables**
49	**7.1 30% Completion**
50	7.1.1 30% Report
51	7.1.2 30% Presentation
52	**7.2 60% Completion**
53	7.2.1 60% Report
54	7.2.2 60% Presentation
55	**7.3 90% Completion**
56	7.3.1 90% Report
57	7.3.2 Practice Presentation
58	7.3.3 90% Website
59	**7.4 100% Completion**
60	7.4.1 Final Presentation
61	7.4.2 Final Report
62	7.4.3 Final Website
63	7.5 Competition Deliverables
64	**8 Project Management**
65	**8.1 Meetings**
93	**8.2 Schedule/Resource Management Meetings**



Project: Project1
Date: Sun 11/22/20

Task	Summary	Inactive Milestone	Duration-only	Start-only	External Milestone	Critical Split
Split	Project Summary	Inactive Summary	Manual Summary Rollup	Finish-only	Deadline	Progress
Milestone	Inactive Task	Manual Task	Manual Summary	External Tasks	Critical	Manual Progress